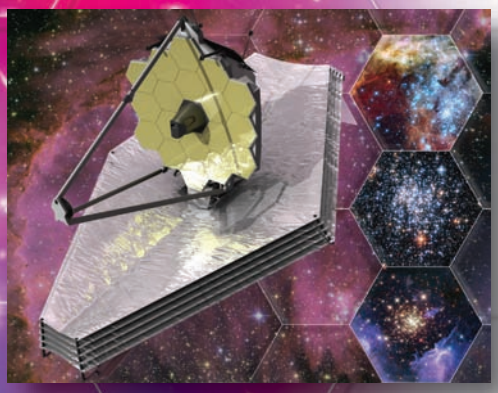
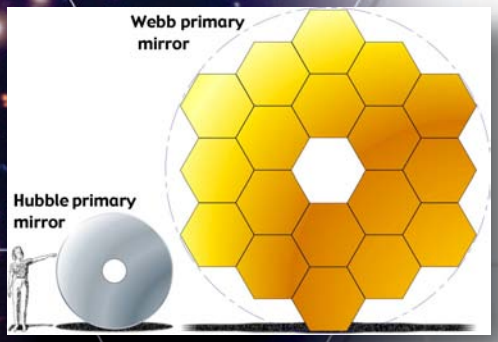
National Aeronautics and Space Administration

Hubble and Webb:
A tale of two telescopes

The Hubble Space Telescope, the iconic astronomical observatory of our times, has spectacularly extended our understanding of the Universe – from nearby planets to the most distant galaxies. As often happens in science, discoveries raise new questions that are sometimes tantalizingly beyond present capabilities. The James Webb Space Telescope is designed to continue - and expand - the legacy of scientific discovery from Hubble.





Both telescopes share similar goals: to explore the Universe and improve our understanding of processes such as the assembly and evolution of galaxies, star birth, and the formation of planets orbiting other stars as well as objects in our own Solar System. This shared purpose is reflected in their common features: mirrors to collect light from distant stars and galaxies, and sensors that convert that light into digital images and spectra. They both work in the vacuum of outer space, and use radio signals to transmit their images to Earth. Both also have solar panels that collect energy to power the telescope, and pointing control systems that keep the telescope extremely stable while taking data.

Despite their similarities, these two telescopes are very different. Webb will be optimized for infrared light, unlike Hubble, which observes in ultraviolet and visible light and has only limited near-infrared capabilities. Webb will also have a much larger primary mirror that will enable it to collect more light than Hubble. Seeing in the infrared is essential for viewing objects at the edge of the Universe, since the light from these far-away objects is red-shifted from the visible into the infrared wavelengths by the expansion of our Universe. Observing far into the infrared also allows Webb to see deep into the dusty cocoons where stars and planets form.

Size Matters

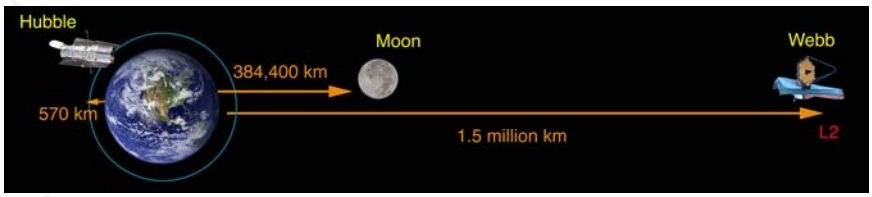
The primary mirror of a telescope collects the light from the objects that the telescope observes. The larger the primary mirror, the more light the telescope collects. The area of Webb's mirror is 6 and a quarter times larger than Hubble's, which will enable it to see objects that are fainter and farther away. Webb's size will allow scientists to peer back to a time when galaxies were just forming!

All of Webb's mirrors have been polished, coated, and cryogenically tested. Here, a set of six are prepped for tests at Marshall Space Flight Center.

One of five full-scale Webb sunshield membranes undergoes tests at Mantech in Huntsville.

Webb is Cool

Since all objects (including telescopes) emit infrared light as a byproduct of their temperature, the telescope and its instruments must be very cold. Webb has a large sunshield that blocks the light from the Sun, Earth, and Moon, which otherwise would heat up the telescope and overpower the astronomical signals. For this to work, Webb must be in an orbit where all three of these objects are in about the same direction. This is achieved by putting Webb in an orbit that is almost a million miles (1.5 million km) from Earth at the second Earth-Sun Lagrange point (L2). This is in contrast to Hubble, which orbits just 350 miles (570 km) above the Earth.



(not to scale)

Technology Improves with the Passage of Time

Webb employs many technologies developed in the years since Hubble was launched. These advanced technologies, also described on our website (www.jwst.nasa.gov), include ultra-lightweight beryllium mirrors; a deployable multilayer sunshield; a super-cold mechanical cryocooler; tiny microshutters used to select specific fields of view; new communications networks to transmit and store large quantities of data; and ultra-sensitive infrared detectors to record extremely faint signals. All of these cutting-edge technologies combine to form a telescope that is about 100 times as powerful as Hubble.

	Hubble	Webb
Mirror Diameter	7.9 ft (2.4m)	21.3 ft (6.5m)
Length	44 feet (13.2 meters)	72 feet (22 meters)
Wavelengths	Ultraviolet, Visible, and Near Infrared: 0.1-2.5 micrometers	Visible, Near Infrared and Mid Infrared: 0.6-28.5 micrometers
Location	Orbiting Earth, ~350 miles (570km) above the surface	Orbiting L2, ~940,000 miles (1,500,000 km) from Earth
Temperature	70F (21C)	-370F (-230C)

Current Status of the Mission

Webb is in the fabrication, assembly and testing phase of its development. All necessary technology developments have been completed. Some of the most challenging tasks, such as making, polishing, coating, and cryogenically testing the beryllium mirror segments are now finished. The rigorous assembly and test phase is now underway.

Webb will be launched later this decade on an Ariane 5 rocket.

The James Webb Space Telescope is an international collaboration between NASA, the European Space Agency, and the Canadian Space Agency.

www.nasa.gov